MECHANICS' MAGAZINE,

AND

REGISTER OF INVENTIONS AND IMPROVEMENTS.

VOLUME IV.] FOR THE WEEK ENDING OCTOBER 18, 1834. [NUMBER 4.

"If it be true that a wise man, like a good refiner, can gather gold out of the drossiest volume, and that a fool will be a fool with the best book,—yea, or without a book,—there is no reason that we should deprive a wise man of any advantage to his wisdom, while we seek to restrain from a fool that which, being restrained, will be no hindrance to his folly."—MILTON.

Animal Mechanics, or Proofs of Design in the Animal Frame. Part II., showing the Application of the Living Forces. [From the Library of Useful Knowledge.]

(Continued from page 154.)

OF SENSIBILITY.—Under this head are comprehended, not any sentiment or feeling of the mind, but the sensations of the body.

We form our notions of sensibility from that of the skin; and it is no doubt necessary that we should do so. It is in constant communication with things around us, and affected by their qualities; it affords us information, which corrects the notions received from the other organs of sense, and it excites our attention to preserve our bodies from injury. We are so familiar with the painful effects of injuries upon the surface, that there is nobody who does not imagine that the deeper the injury the more dreadful the pain. But, on the contrary, it is a well established fact, that to such irritants as would give the skin pain, the internal parts are totally insensible. And it is equally certain, that though the nerves, the instruments of sensation, are incapable of producing any perception without the brain, yet the brain itself, the part which is the seat of intellect, and to which every impression must be referred before we become conscious of it, is itself as insensible as leather. These considerations show us, that sensibility to pain is not a necessary result of life, and they naturally lead to the inquiry for what purpose is sensibility bestowed, and how is it distributed in the body?

We have first to show that the skin has sensibilities exactly suited to the functions it has to perform. Science no doubt informs us, that warmth and cold are only relative degrees of heat; to the skin they are distinct sensations, and excite in different ways both the mind and the bodily functions. Cold braces and animates to exertion, whilst the warmth, which is pleasant to us, is genial to all the operations of the animal economy. Their alternations are the most constant sources of our enjoyment, and at the same time conduce to exertion and to health. All this, however, belongs to the skin exclusively; parts internal, although peculiarly sensible to their proper stimulus, give no indication of sensibility to heat; if there be internal sensibilities of heat, they are morbid and deceptious. Molten lead would produce pain and death, being poured into the interior of the body, but the sensation of burning is a property of the surface only. It is the excess of that particular sensation, which is calculated, like the other endowments of the skin, to suit the medium in which we live, and to force us to the regulation of the temperature necessary to preserve life.

Touch, or the sensibility to bodies pressed upon the skin, is likewise a distinct and appropriate sense. The sensibility of the skin to pricking, cutting, or tearing, is also in curious contrast with the sensibility of the solid internal textures, as bone, cartilage, and ligament. We have arrived at the full comprehension of this subject very slowly. Disagreeable experiments have been made, but the following is as interesting as it was innocently performed. A man who had his finger torn off, so as to hang by the tendon only, came to a pupil of Dr. Hunter. "I shall now see," said the surgeon, "whether this man has any sensibility in his tendon." He laid a cord along the finger, and, blindfolding the patient, cut across the tendon. "Tell me," he asked, "what I have cut across?" "Why, you have cut across the cord, to be sure," was the answer. By such experiments it became very manifest, that bone, gristle, and ligament, were insensible to pricking, cutting, and burning. Were they therefore insensible? The reader will answer—Surely, it is a matter proved. But before we finally decide, let us take this into consideration,—that the sensibilities of the body differ in kind as well as in degree; and every part has its peculiar kind, as well as its degree; and every part has its kind of

sensibility with reference to its function, and also with reference to its protection from violence. If the membranes between the bones of our great joints, or the cords which knit the bones, were sensible in the same manner and degree with the skin, we should be incapable of motion, and screwed to our seats, as the man appears to be who has a violent attack of acute rheumatism.

But although these bones and cartilages, or gristles, and ligaments, be not sensible as the skin, or the surface of the eye, they possess that which is suited to their condition, which permits their free use, and yet limits that too free exercise which would be injurious to their textures, or raise inflammation in them. The ligaments and tendons, then, which are insensible to pricking, cutting, and burning, are sensible, nevertheless, to stretching and tearing! It is remarkable that such men as Drs. Hunter and Haller, the luminaries of their science, should have held the opinion that the bone and the membrane which covers it (the *periosteum*), the gristles or cartilages, the ligaments of joints, and the tendons of muscles, were insensible parts, and yet be in daily attendance on those who suffer the pain of a sprained ankle, where there are no parts to suffer but those enumerated, and where the pain, excessive in degree, was felt in the instant of the sprain. These considerations explain to us that pain is the safeguard of the body. This capacity of conveying painful impressions to the mind is not given superfluously to all parts; on the contrary, the safe exercise and the enjoyment of every part is permitted without alloy, and only the excess restrained.

This subject is finely illustrated by the apparent insensibility of the heart. The observation of the admirable Harvey, the discoverer of the circulation of the blood, is to this effect. A noble youth, of the family of Montgomery, from a fall and consequent abscess on the side of the chest, had the interior marvellously exposed, so that after his cure, on his return from his travels, the heart and lungs were still visible, and could be handled; which, when it was communicated to Charles I., he expressed a desire that Harvey should be permitted to see the youth and examine his heart. "When," says Harvey, "I had paid my respects to this young nobleman, and conveyed to him the king's request, he made no concealment, but exposed the left side of his breast, when I saw a cavity into which I could introduce my fingers and thumb; astonished with the novelty, again and again I explored the wound, and first marvelling at the extraordinary nature of the cure, I set about the examination of the heart. Taking it in one hand, and placing the finger of the other on the pulse at the wrist, I satisfied myself that it was indeed the heart which I grasped. I then brought him to the king that he might behold and touch so extraordinary a thing, and that he might perceive, as I did, that unless when we touched the outer skin, or when he saw our fingers in the cavity, this young nobleman knew not that we touched the heart!" Other observations confirm this great authority, and the heart is declared insensible. And yet the opinions of mankind must not be lightly condemned. Not only does every emotion of the mind affect the heart, but every change in the condition of the body is attended with a corresponding change in the heart: motion during health—the influence of disease—every passing thought, will influence it. Here is the distinction manifested. The sensibility of the skin is for a purpose, and so is the sensibility of the heart. Whilst the skin informs us of the qualities of the external world, and guards us against injury from without, the heart, insensible to touch, is yet alive to every variation in the constitutional powers, and subject to change from every internal influence.

There is in the several organs of the body, as it were, a distinct life; that is, they possess sensibility, the grand endowment of life, necessary to their condition, and adapted to their appropriate stimulus. The impressions made upon them will sometimes rouse them into activity, or call muscles into action which are necessary to their functions or for their protection; and this oftentimes without reference to the mind at all, and consequently without our consciousness.

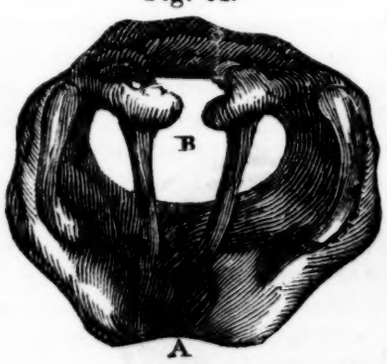
Perhaps we have the most agreeable example of this in the eye. That organ has been selected in the Preliminary Discourse of the Objects and Pleasures of Science, as showing how mechanical advantage is taken in the arrangement of the muscles to produce velocity of movement in guarding the eye. But this fine mechanism would be lost if the excitement depended on our will,—if there were not a sensibility appropriated to the action, and an influence quicker than thought. It is not by feeling the pain of the offensive body, or by estimating its dangers, and acting on the conviction, that we close the eye to avoid injuries. This would be an operation all too slow for the intended purpose; and, therefore, the muscles, possessing these extraordinary provisions, are put in relation with a sensibility more admirable still. So when a light foreign body touches the eye-lashes, they give alarm, and cause a motion, both of the eye-lids and eye-

ball, quicker than thought. The eye-lashes, seated on the tender extremities of sensitive nerves, preserve the eye in two ways—by guarding its interior from the lateral light, and by exciting the motion of the eye-lids, even before the offensive body can touch the eye's surface.

We may take another illustration to show how sensibility, one of the endowments of the living part, is adapted to the mechanical organization, and with an appropriation more admirable than the mechanism. When we speak of the sensibility of the skin, it is still possible to misconceive its nature, and to suppose it accident merely; but in the instance to be adduced, the sensibility is different, and it is put in connection with a hundred muscles; without this high and peculiar sensibility, and its multiplied relations to muscles, independent of volition, the mechanism we are about to describe would be quite useless.

The top of the wind-pipe is called the *larynx*, and consists of five elastic cartilages. These do not merely keep the sides of the wind-pipe apart, and the passage for the breath free, but they perform offices important to the economy both of body and mind; they are an essential part of the instrument of voice; they at the same time guard the lungs from injury.

Fig. 24.



The *thyroid* cartilage is the largest of the cartilages of the larynx, it is that we feel projecting on the fore part of the throat, called the *pomum adami*, (A.) It is a protection to the fine apparatus behind it, and indeed this is the reason of its name, (*scutiform*, like a shield.) Within the thyroid stand the *arytænoid* cartilages, (B.) This cartilage is of an irregular triangular form. It is socketed or articulated on the cartilage below, and is perfectly moveable. To the corner which projects forwards the ligament (B) is fixed, and to its other sides five little muscles are attached; these muscles, by moving the cartilage, draw and vary the position of the ligament. It is these cartilages and this ligament, which, vibrating in the stream of air, give the tremor, and vocalize the breath; the tones so produced are articulated in speech.

Fig. 25.

This is a subject far from being exhausted in our philosophical works, and may call for observation afterwards;* but at present we may look on these ligaments, not as the *cordæ vocales*, but in another of their offices —forming the slit which opens and shuts in breathing, for the protection of the lungs. But here it is pertinent to remark, that in the structure of an animal body one organ is made subservient to several functions, without interference in the performance of any of them. This is especially true of the larynx. It is one of those uses only, and the least important, that we have at present to observe.

The ligaments being invested with the lining coat, or membrane of the wind-pipe, draw it into the form of a slit like the till of a shop counter, and this is the chink of the glottis (*rima glottidis.*) This slit opens and closes with every inspiration, moving as we see the nostrils do in breathing. But the most admirable thing of all is the acute sensibility given to this part, and to no other, so that the lightest husk, or seed, or smallest fly, drawn in with the breath, and touching the margin of the chink, is caught there by the rapid action of the muscles and consequent closing of the aperture. Now, were the provision for the protection of the lungs to be only thus far perfect, there would be an effectual means of preventing the intrusion of foreign matter into the delicate cells of the lungs, but not for its expulsion from the entrance which it had reached. Accordingly, although the sensibility of the glottis is put in operation with the shutting of the chink, it also animates another class of muscles, viz. all those which, seated on the chest, compress it, and force out the air in coughing; and these combining in one powerful and simultaneous effort, whilst the

* For a full description of the Vocal Organs, together with engravings illustrative of the same, the reader is referred to page 117, vol. iii. of this Magazine.

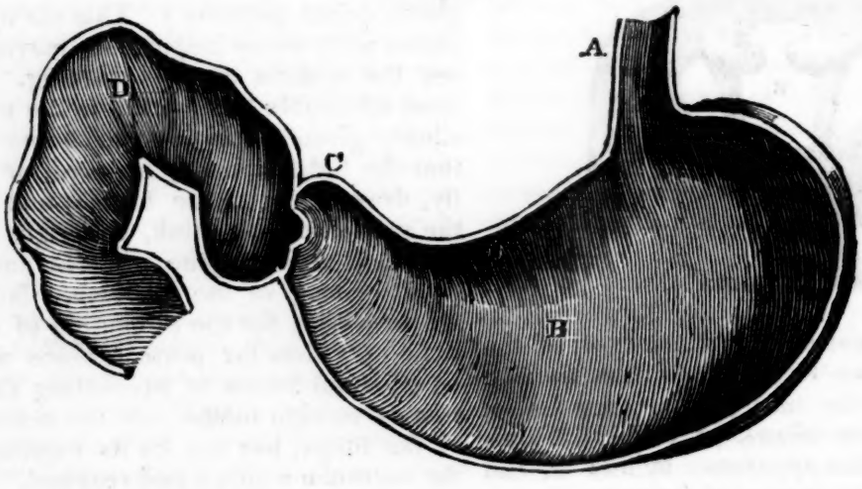
glottis is closed, overcome that constriction, and propel the breath through the contracted pipe with an explosive force, which brushes off the offending body. There is one thing more necessary to this most important though familiar action—the lungs are never empty of air: in breathing we do not fully expel the air; if we did, there would be a period of danger occurring 17 times in a minute, for in the first part of each inspiration, something might be drawn into the wind-pipe which would suffocate. But by this provision of air retained in the lungs more than necessary to respiration, and which it is possible to expel by a more forcible expiration, there is always a possibility of coughing and expelling the offensive thing at any point of time in the act of inspiration.

The sensibility seated in a spot of the throat so beneficently, does not extend into the wind-pipe; for we cannot more admire the perfect adaptation of this living property, than the circumstance of its never being bestowed in a superfluous degree, nor extended where it is not absolutely required. Just as the sensibility of the skin protects the parts beneath, so in the same manner does the sensibility of the top of the wind-pipe protect all the interior of the tube, and the lungs themselves, without the necessity of this property of irritability extending through the whole continuous surface.

The simple act of sneezing affords a very curious instance of the mutual adaptation of muscular activity and the governing sensibility. The sensation which gives rise to this convulsive act is seated in the membrane of the interior of the nostrils, and we are not surprised with the difference of sensation from that in the throat which excites coughing. But is it not a very curious thing to find some twenty muscles thrown out of the action excited by irritation of the nose; and as many excited which were not in the class of those influenced in coughing; and for the very obvious purpose of shutting the passage by the mouth, or at least forcibly driving the air through the nostrils? No act of the will could so successfully propel the air through the nose in such a way as to remove the offensive and irritating particles from the membrane of the nose, and clear those passages.

These last examples of an appropriate sensibility might introduce us to an acquaintance with those internal sensibilities which govern the actions of parts quite removed from the influence of the will; but the description of them may be deemed unnecessary. We shall just hint at the guard which nature has placed on the lower orifice of the stomach, to check the passage which the appetites of hunger and thirst may have given at the upper orifice (A) to

Fig. 26.



aliments not easy of digestion. This lower orifice (C) is encircled with a muscular ring; the ring is in the keeping of a watchful guard. If we are employing the language of metaphor, it is of ancient use. The Greeks called this orifice *pylorus*, which signifies a porter,* and his office is this: When the stomach has received the food, it lies towards the left extremity, or is slightly agitated there. When the digestive process is accomplished, the stomach urges the food towards the lower orifice. If the matter be bland and natural, it passes, and no sensation is experienced. But if crude and undigested matter be presented, opposition is offered to its passage, and a contention is begun which happily terminates in the food be-

* The upper orifice was called by them *œsophagus*, as it were the *purveyor*, from two words signifying to bring food.

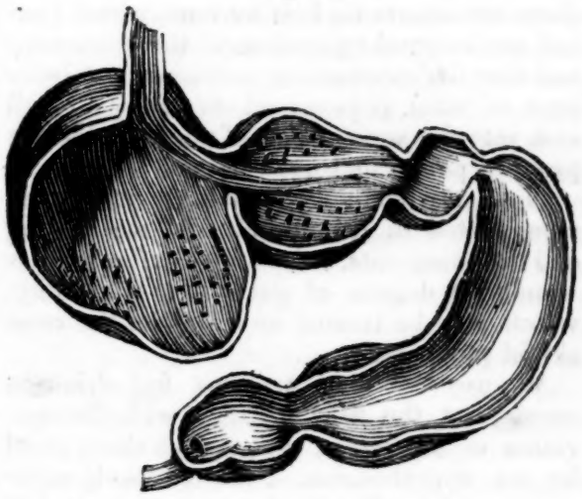
ing thrown again to the left extremity of the stomach, to be submitted to a more perfect operation of the digestive powers seated there. It is during this unnatural retrograde movement of the food that men are made sensible of having a stomach. Yet the sensations, how unpleasant soever, are not to be regarded as a punishment, but rather as a call on reason to aid the instinctive powers, and to guard against disease by preventing impure matter from being admitted into the portion of the intestinal canal which absorbs, and would thus carry, those impurities into the blood to engender disease.

Such are a few examples of the variety in the sensibilities of the animal frame; guarding us against external influences when they would threaten destruction to the framework, and adjusting the operations of internal parts too complicated and too remotely situated for the superintendence of reason.

Medical authors, without being empirics, do, notwithstanding, take great advantage of our ignorance. We can all of us take warning from the sensations experienced in the process of digestion, and there can be no harm in giving every man a confidence in the sensibility of his stomach, and in its indications of healthy or disturbed functions. We have the best proof of what we wish to inculcate in the action of the ruminating stomach. A cow swallows the gross herbage, and fills its large first stomach. When it chews the cud, the stomach, by its action, rolls up the grass into distinct pellets, or balls, with as much regard to the office of its being rejected into the mouth, as we do in masticating for swallowing. When the ball is brought into the mouth and chewed, it is again swallowed; but in descending into the lower part of the gullet, a muscle draws close the aperture by which it passed into the large stomach in the first instance, and it is now ushered into a second stomach, and so successively onwards to that stomach in which the digestion is performed. The curious muscular apparatus by which this is accomplished needs not to be described; but surely, the sensibility which directs it, which, kept apart altogether from the will, is yet in its results so like the operations of reason, presents a subject of just admiration.

The elastic structure of the camel's foot, the provision around its eyes for ridding them of offensive particles, the power of closing its nostrils against the clouds of sand, and its endurance of fatigue, would not enable it to pass the desert, unless there were provisions for the lodgement of water in its stomach, and unless this apparatus were animated by peculiar sensibilities; for there

Fig. 27.



are muscles to retain the fluid in the cells of its stomach, only permitting it to ooze out according to the necessities of the animal; and there is a muscle, represented in the figure above, which pulls up the one or the other of the orifices of the different stomachs, to receive the food from the lower end of the gullet, according to its condition, whether to be deposited merely as in a store, or to be submitted to the operation of digestion.

The surprising thing in all this is not so much the mechanical provision as the governing sensibility. What, for example, should in the first place impel the grosser food, when collected, into the first stomach? What should, in the next place, and after rumination and mastication in the mouth, carry it into the third stomach; since water is carried into neither of these, but into the cells of the second stomach?

Yet, after all, this only brings us back to a sense of the operations of our own bodies. The act of swallowing, the propulsion of the food into the gullet, and the temporary closing of the wind-pipe at such a time, is just as surprising. This latter operation is never deranged but by the interference of the will. If the individual attempts to speak, that is, to govern these parts by the will, when they should be left to these instinctive operations, or if terror, or some such mental excitement, prevail at the moment of swallowing, then the morsel may stick in the throat.

All this shows how perfect the operations of nature are, and how well it is provided that the vital motions should be withdrawn from the control of reason, and even of volition, and subjected to a more uniform and certain law.

But the point to which we would carry the reader is this, that though there are the proper sensibilities of the body, with refer-

ence to perception or consciousness, yet there are others no less curious, which control the internal operations of the economy; and that the mechanical provisions are but a type of what is promised to him who will look into the sensibilities of the body for the proof of power and contrivance.

Now, the human stomach, though not so complicated in its apparatus of macerating and digesting vats, is possessed of a no less wonderful degree of governing sensibility, which may be trusted as surely as the most skilful physiologist.

We are told that we must not drink at meals, lest the fluid interfere with the operation of digestion; and of this there need be no apprehension. The stomach separates and lets off with the most curious skill all superfluous fluid through its orifice, while it retains the matter fit for digestion. It retains it in its left extremity, permitting the fluid to pass into the intestines, there to supply the other wants of the system no less important than the digestion. The veterinary professor, Coleman, ascertained that a pail of water passed through the stomach and intestines of a horse at the rate of ten feet in the minute, until it reached the cæcum. Drinking at a stated period after meals, say an hour, is at variance with both appetite and reason. The digestion is then effectually interfered with; for what was solid has become a fluid, (the *chyme.*) This fluid is already in part assimilated; it has undergone the first of those changes which fit it ultimately to be the living blood; and the drink mixing with this chyme in the inferior extremity of the stomach, or first intestine, must produce disturbance, and interrupt the work of assimilation.

Looking in this manner upon the very extraordinary properties of the stomach, we perceive how natural it was for physicians to give a name to the sensibility of which we have been speaking. The *Archeus* of Vanhelmont, the *Anima* of Stahl, were the terms used to designate this nature, principle, or faculty, subordinate to and distinct from perception: a notion entertained, and more or less distinctly hinted at, by philosophers from Pythagoras to John Hunter.

A modern philosopher,* of whom, in this instance, it would be difficult to say whether he be serious or playful, with some plausibility, however, asserts that it might be possible to carry on the business of life without pain. If animals can be free from it an hour, they might enjoy a perpetual exemption from it. Animals might be constantly in a state of enjoyment; instead of pain, they might feel a diminution of pleasure, and might thus be prompted to seek that which is necessary to their existence.

In the lower creatures, governed by instinct, there may be, for aught we know, some such condition of existence. But the complexity and delicacy of the human frame is necessary for sustaining those powers or attributes which are in correspondence with superior intelligence; since they are not in relation to the mind alone, but intermediate between it and the external material world. Grant that vision is necessary to the developement of thought, the organ of it must be formed with relation to light. Speech, so necessary to the developement of the reasoning faculties, implies a complex and exceedingly delicate organ, to play on the atmosphere around us. It is not to the mind that the various organizations are wanted, but to its condition in relation to a material world.

The necessity of this delicate structure being admitted, it must be preserved by the modifications of sensibility, which shall either instinctively protect the parts, or rouse us into powerful and instantaneous activity. Could the eye guard itself, unless it possessed sensibility greater than the skin? Could it guard itself, unless this sensibility were in consent with an apparatus which acted as quick as thought? Could we, by the mere influence of pleasure, or by any cessation or variation of pleasurable feelings, be made alive to those injuries which might reach the lungs by substances being carried in with the air we breathe? Is there any thing but the sense which gives rise to the apprehension of suffocation, that would produce the instant and sudden effort which could guard the throat from the intrusion of what was offensive or injurious. Pleasure is at the best a poor motive to exertion, and rather induces to languor and indulgence, and at length indifference. To say that animals might be continually in a state of enjoyment, and that when urged by the necessities of nature, such as thirst, hunger, and weariness, they might only feel a diminution of pleasure, is not only to alter man's nature, but external nature also; for whilst there are earth, rocks, woods, and water, for our theatre of existence, the texture of our bodies must be exposed to injuries from which they can only be protected by a sensibility adapted to each part, and capable of rousing us to the most animated exertions. Take away pain, and take also away the material world, by which we are continually threatened with injury, and what, after all, is this

* Hume.

but imagining a future state of existence, instead of that in which mind and matter are combined? If all were smooth in our path, if there were neither rugged places nor accidental opposition, whence should we derive those affections of our minds which we call enterprise, fortitude, and patience?

Independent of pain, which protects us more powerfully than a shield, there is inherent in us, and for a similar purpose, an innate horror of death. "And what thinkest thou, (said Socrates to Aristodemus,) of this continual love of life, this dread of dissolution, which takes possession of us from the moment that we are conscious of existence?" "I think it, (answered he,) as the means employed by the same great and wise artist, deliberately determined to preserve what he has made."

The reader will no doubt here observe the distinction. We have experience of pain from injuries, and learn to avoid them; but we can have no experience of death, and therefore the Author of our being has implanted in us an innate horror at dissolution, and we may see this principle extended through the whole of animated nature. Where it is possible to be taught by experience, we are left to profit by it, but where we can have none, feelings are engendered without it. And this is all that was necessary to show how the life is guarded: sometimes by mechanical strength, as in the skull; sometimes by acute sensation, as in the skin, and in the eye; sometimes by innate affections of the mind, as in the horror of death, which will prevail as the voice of nature, when we can no longer profit by experience.

But the highest proof of benevolence is this, that we have the chiefest source of happiness in ourselves. Every creature has pleasure in the mere exercise of his body, as well as in the languor and repose that follow exertion; but these conditions are so balanced, that we are impelled to change, and every change is an additional source of enjoyment. What is apparent in the body is true of the mind also. The great source of happiness is to be found in the exercise of talents, and perhaps the greatest of all is when the ingenuity of the mind is exercised in the dexterous employment of the hands. Idle men do not know what is meant here; but nature has implanted in us this stimulus to exertion, that she has given to the ingenious artist—the man who invents, and with his hands creates, a source of delight, perhaps greater, certainly more uninterrupted, than belongs to the possession of higher intellectual powers, and far beyond any that falls to the lot of the minion of fortune.

We believe that every thinking person may have wherewithal in his own sphere to tutor him, and bring him to the temper of mind and belief which we would inculcate. Yet there is something peculiarly appropriate in the study of our own bodies. In chemistry we are so much the agents as to forget the law, and the law itself seems at least to intermit. But in the changes wrought in the animal frame, the directing power is uniform in its influence, and holds all in harmony of action.

We now learn without difficulty and without mystery, what is meant by organic and animal sensibility. The first is that condition of the living organ which makes it sensible of an impression, on which it re-acts and performs its functions. It appears from what has preceded that this sensibility may cause the blowing of a flower, or the motion of a heart. The animal sensibility is indeed an improper term, because it would seem to imply that its opposite, organic sensibility, was not also animal; but it means that impression which is referred to the sensorium; where, (when action is excited,) perception and the effort of the will are intermediate agents between the sensation and the action or motion.

We may sum up the inquiry into sensibility and motion thus:

1. The peculiar distinction of a living animal is that its minute particles are undergoing a continual change or revolution under the influence of life. Philosophers have applied no term to these motions.

2. An organ possessed of an appropriate muscular texture, and of sensibility in accordance with the moving instrument, as the heart, or the stomach, has the power of action without reference to the mind. The term *automatic*, sometimes given to those motions, conveys a wrong idea of the source of motion, as if, instead of being a living power, it were consequent upon some elastic or mechanical property.

3. There are sensibilities bestowed on certain organs, and holding a control over a number of muscles, which combine them in action in a manner greatly resembling the influence of the mind upon the body, yet independent of the mind: as the sensibility which combines the muscles in breathing.

4. In the last instance, a large class of muscles were combined without volition. But the whole animal fabric may be so employed, as in the instinctive operations of animals, where there is an impulse to certain actions not accompanied by intelligence.

5. A motive must exist before there are voluntary actions, and hence philosophers

have supposed that there can be nothing but instinctive actions in a new-born child. But we must distinguish here what are perfect at first, and what are imperfect and irregular, and become perfect by use and the direction of the will. The act of swallowing is perfect from the beginning. The motions of the legs and arms, and the sounds of the voice, are irregular and weak, and imperfectly directed. It is the latter which improve with the mind. From not knowing the internal structure, and the arrangement of the nerves, philosophers, as Hartley, supposed that an instinctive motion, such as swallowing, may become a voluntary act. Volition in the act of swallowing consists merely in putting the morsel within the instinctive grasp of the fauces, when a series of involuntary actions commence, over which we have no more control in mature age than in the earliest infancy. Swallowing is not a voluntary action, and the thrusting the morsel back with the tongue is like putting the cup to the lip. It is the preparation for the act of swallowing that is voluntary, but over the act itself we have no control.

It is an error to suppose that all muscular actions are in the first instance involuntary, and that over some of them we acquire a voluntary power. The power of volition over the muscles of the body is provided for by appropriate nerves, and no apparatus which is not supplied with that particular class of nerves can ever by any exercise or study become subject to volition. A child's face has a great deal of motion in it, very diverting from its resemblance to expression, before there can be any real motive to the action. It will crow, and make strange sounds, before there is an attempt at speech. But this gradual developement of intelligence and acquisition of power ought not to be called the will attaining influence over involuntary muscles; since, in fact, the apparatus of nerves and muscles is prepared, and waits for the direction of the mind with so perfect a readiness as to fall into action and just combination, before that condition or affection of the mind which should precede the action takes place. A child smiles before any thing incongruous can enter the mind, before even pleasure can be supposed a condition of the mind. Indeed, the smile on an infant's face is first perceived in sleep.

6. All the motions enumerated above are spontaneous motions belonging to the internal economy; but the external relations of the animal, the necessity of escaping from injury, or warding off violence, require a sensibility suited to those outward impressions, and an activity consequent on volition. Nothing less than perceptions of the mind, and voluntary acts, suited to a thousand circumstances of relation, could preserve the higher classes of animals, and man above all others, from destruction.

All these provisions proceed from an arrangement of nerves and muscles. The mechanical adjustment of the muscles and tendons is perfect, according to the principles of mechanics. The muscles themselves possess a different property; they are irritable parts; motion originates in them. This living property of contraction is admirably suited, in each particular muscle, to the office it has to perform. In some it is suitable that the muscles should act as rapidly as the bowstring on the arrow; in others the action is slow and regular; in others it is irregular, and after long intervals, according as the functions to which they are subservient require. The motions of the limbs, the motions of the eye, those of the heart and arteries, stomach, and bowels, are all different. This appropriation of action is not in the muscles themselves, but as they stand in relation to the nervous system, and the sensibilities which impel them.

We hope, then, by the course we have taken, that we have carried the reader to a higher sense of the perfection of the animal structure. We first drew him to observe provisions in the strengthening of the bones, the adjustment of their extremities to the joints, the course of the tendons, and other such mechanical appliances, proving to him the existence of intention in the formation of the solid fabric of the body. We have then explained how that motion is produced which was at all times familiar to him, but even the immediate causes of which he did not comprehend. We have in the last place shown him, that under the term life he has a still more admirable subject of contemplation in the adjustment of those living properties; in the sensibilities differing not so much in degree as in kind; and in their appropriation, both to the operations of the internal economy, and to the relations external, and necessary to safety.

It is not possible to contemplate these things without having the full proof before us of the power of the Creator in forming and sustaining the animal body. As a man with *gutta serena* may turn his eyes to the sun, and feel no influence of light, so may the understanding be blind to these proofs; and we may say with the celebrated Dr. Hunter, that he who can contemplate them without enthusiasm, must labor under a dead palsy in some part of his mind, and we must pity him as unfortunate.

Some More Notes on Mr. Nutt's Book on Bees.

[From the London Mechanics' Magazine.]

Sir,—In consequence of your inserting in your Magazine my remarks on Mr. Nutt's book, I am emboldened to continue them ;* but in doing so I shall endeavor to be as concise as possible.

We are told, "on rising early one morning in July, 1827, and walking into an apiary, as my custom then was and still is, I found that some malicious wretch had been there before me, and overturned a fine colony of bees." Is it not possible that the fine colony of bees, by being placed, as we are informed they were, on a square box, toppled off (to use an expression of Mr. Nutt's) of their own accord, without the assistance of "the malicious wretch?" Sir Joseph Banks, if Dr. Walcot can be relied on, was once the occasion of a similar accident when engaged in some interesting entomological pursuits.

Mr. Nutt, with "invention ever new," immediately converts the malice of this "malicious wretch" into a great benefit, for it leads to the invention of a bee-hive at least equal in value to his "matchless one." It is called the inverted hive, though, to a plain bee master like myself, to turn a bee-hive topsy-turvy appears an absurdity. Indeed, Mr. Nutt, when enumerating his objections to the practice of driving bees, acknowledges it to be so. He says they are turned topsy-turvy, and describes it very truly as a "strange unnatural position," though when descanting on the merits of his own invention it becomes instanter the very best possible position. Mr. Nutt must, however, have overlooked one inconvenience arising from it—at least, so it appears to me. The cells in the comb, as built by the bees in the hive, have an inclination so great as to admit of being completely filled with honey, without requiring to be sealed with wax, which is never done, excepting the honey is intended for use in winter. By turning the hive topsy-turvy, as in this unique invention, if there be any honey in the cells at the time the operation is performed, (which is extremely probable, as it is recommended to be done between the months of March and October,) every drop will run out, and lodging at the bottom of the hive, will probably destroy the greatest part of the bees, and those not absolutely killed will be so daubed with it as never after to be able to fly—an objection, by the way, which Mr. Nutt avails himself of, and strenuously urges when condemning the storying practice. There is another very powerful objection to this topsy-turvy hive, which must be obvious to every one. When a hive is placed, as it usually is, on a stand, by carefully lifting it on one side, the stand can be easily cleaned (which Mr. Nutt very properly recommends to be frequently done); but how is such an operation to be performed when the hive is turned topsy-turvy? It is impossible. Every thing must fall to the bottom of the hive, where it will accumulate and become an intolerable nuisance, there being no mention made of any semi-lunar hole through which the filth might be extracted. Besides these objections, the expense of fitting up one of these topsy-turvy hives must be so enormous as to counterbalance any advantage to be derived from it. The only part, after all, of this invention, to which Mr. Nutt has any claim, is the topsy-turvy part—all that relates to the glasses is entirely the invention of the late Mr. Wildman. I purchased some years ago, at the shop of Mr. Wildman, just above Middlerow, Holborn, a straw hive, with a flat wood top to place glasses on, with proper apertures cut for the bees to work through into them, exactly as I understand to be the case in Mr. Nutt's inverted hive; and I now get excellent straw hives, made in a similar manner, at a less price than 4s. There are boxes made on the same construction, I believe, by Mr. Milton, of Marylebone street, who also furnishes the requisite glasses. It is farther worthy of observation, that Wildman gives in his book plates of all his hives —*these hives with glasses on them among the number*—and that Mr. Nutt mentions in his preface that some friend had made him a present of this very book.

We come at length to the most prominent of all Mr. Nutt's inventions, that invention which, according to his distinguished patron, the "learned lord," is "a more ingenious contrivance" than was ever "put into operation by any other man." It is called the "observatory hive," afterwards the "grand hive;" and as if neither of these titles was sufficiently distinctive, ultimately the "blessed hive."

> "By this bless'd hive our ravish'd eyes behold
> The singing masons build their roofs of gold."

"Singing masons!" I have long and anxiously studied the sublime mysteries of masonry, and obtained the very highest degrees conferred by our grand professors; but this

* We think our correspondent's remarks are written in the spirit of truth, and therefore willingly insert them; which we do the more readily, that though ample time has been afforded to Mr. Nutt and his admirers to refute the former strictures of the same writer, they still remain unrefuted in every essential particular—the friendly efforts of Mr. Booth and K. notwithstanding.—[Ed. L. M. M.]

is the first time I ever heard of its being a characteristic of a good mason to sing at his work. No: such things are never thought of by any of my brethren until they have ceased labor, and are partaking refreshment. I do not deny that some unworthy characters may be found in so numerous a body as my craft consists of. By tradition, we know that two pestilent fellows were engaged in the building of Solomon's Temple, and the atrocious act they committed is still deeply deplored by all good masons. I apprehend the idea that masons mis-spend their time in singing was communicated to Mr. Nutt by his noble patron the "learned lord," who, from his acquaintance with the ancient authors, has no doubt read the following story, which is to be found in Thomas Bozius de Signis Ecclesiæ: "How certaine theeves, having stolen the silver boxe wherein the wafer gods used to lye, and finding one of them there, being loth, belike, that hee should lye abroad all night, did not cast him away, but laid him under a hive: whom the bees acknowledging, advanced him to an high roome in the hive, and there in stead of his silver boxe, made him another of the whitest waxe: and when they had so done, in worship of him, at set houres they sung most sweetly beyond all measure about it: yea, the owner tooke them at it at midnight, with a light and all. Wherewith the bishop being made acquainted, came thither with many others; and lifting up the hive, hee saw there neere the top a most fine boxe, wherein the host was laid, and the quires of bees singing about it, and keeping watch in the night, as monkes doe in their cloisters. The bishop, therefore, taking the host, carried it with the greatest honor into the church; whither many resorting, were cured of innumerable diseases." The conclusion which the author necessarily inferreth thereupon is better than all the rest: "Ex his necesse dicamus in eucharistia verum Christi corpus esse."

This "blessed hive," Mr. Nutt observes, "*at first sight* may probably appear a piece of complicated machinery." But what at second sight? I will venture to answer for every person who has read or may read Mr. Nutt's description—"just as complicated as before!" I have read the description of every steam engine which has appeared in the Mechanics' Magazine ever since its first publication, and, with the assistance of the accompanying plates, could always understand the machine described as well as a person not being a professed or scientific mechanic could be expected to do; but although I have read the description of the "observatory hive" ten times over, I am still as much in the dark as to what constitutes its peculiar excellence, as I was before I possessed Mr. Nutt's book. I am almost tempted to believe Mr. Nutt did not intend that the reader should understand his description; it has certainly as much the air of a deliberate piece of mystification as any thing I ever met with. I must, however, return my thanks to Mr. Nutt for one piece of information he has given of *great importance*, which is, that in writing the description of this "grand," this "blessed" hive, he did not consume the midnigh toil, but used "a *tallow* candle of his *own* making, stuck in a *telescope* candlestick, with a *square* foot!"

The directions for stocking with bees this observatory hive are too diffuse to remark on; but I cannot avoid noticing the pertinacity with which Mr. Nutt maintains his assertion, that two hives of bees will quietly unite on being put together, and become as one family. The observatory hive, in summer, consists of two distinct families—one inhabiting the topsy-turvy part, and the other what is properly the observatory or part to peep into. A piece of mechanism resembling the telescope candlestick, used by Mr. Nutt when writing the description of it, keeps the two families completely separated during the summer; but on a slide being withdrawn in the autumn, the bees in the observatory part are said to quit their summer residence and join their topsy-turvy neighbors, who, strange to tell, quietly unite with them: the united bodies continuing henceforward, according to Mr. Nutt, to labor as one family. I have before observed, and again repeat, that they will do no such thing without fighting. Their combats, in such cases, are carried on with all the animosity of two hostile tribes of Indians—a fact well known to every person who is the least acquainted with the habits of bees.

The only farther notice I shall take of Mr. Nutt's "grand" or "blessed" hive, is to mention that the thermometer, which he had previously taught us to believe was an indispensable instrument in the humane management of the honey bee, is dispensed with in this as well as in the topsy-turvy hive. Are we to infer from this that it is a matter of no consideration whether the bees in either of *these* hives are treated humanely or not?

I am now come to the chapter on fumigation, which appeared in the Mechanics' Magazine,* by which I was enabled, previously to possessing Mr. Nutt's book, completely

* See page 174, vol. i. of this Magazine.

to demolish every pretension he could possibly have to call himself the discoverer of that process, although he arrogates to himself all the merit of it. I refer to my letter inserted in the Mechanics' Magazine of the 11th January last, in which I proved that he had copied the whole of his directions how to perform the operation, *verbatim*, from the work of Mr. Thorley, which no other person, to use the language of the learned lord, "save Mr. Nutt," would have done, without mentioning the source from whence he obtained the information. But this is not all.

I am now able to prove that fumigating bees was a common custom 150 years before even Mr. Thorley wrote his book. I possess an elaborate work, written by that profound scholar and learned physician, Dr. John Gerard, called his "Herbal," my edition of which was printed in 1597, and I shall extract from it what is said respecting the very fungus Mr. Nutt uses for his *newly* discovered process of fumigation. From this it will appear that Mr. Nutt and his apiarian pupils, both patrician and clerical, have been using a very dangerous article. The Doctor's words are, "It is called fungus orbicularis, or lupi crepitus; some do call it fungus lucernarum, in English fusse balls, pucke fusse, and bull fists, which in some places of England they use, being set on fire to kill or smolder their bees when they would drive the hives, and bereave the poor bees of their meat houses and lives, for which purpose it fitly serveth. In form they are very round, sticking and cleaving unto the ground, without any stalks, at first white, but afterwards of a duskish color, having no hole or breach in them whereby a man may see into them, but being trodden upon do breake forth a most thin and fine powder, like unto smoke, very noisome to the eies, causing a kind of blindnesse, which is called poore blinde or sand blinde; for it has been often seen that divers have been blinde ever after, when a small quantity hath been blown into their eies."

Mr. Nutt, at the commencement of his 14th chapter, admits that, in the previous one, he had been to sea without a pilot—the meaning of which nautical phrase, if I understand it, is that he had been writing on a subject of which he was entirely ignorant: an admission which he might have made with equal propriety at the commencement of every chapter in his book. The opinion which he entertains, that the old queen bee leaves her hive with the first swarm, I do not myself entertain, although Dr. Bevan does; but as the Doctor, in his work on bees, makes no mention of having made any experiment himself to ascertain the fact, I do not feel bound to pay much attention to the Doctor's dictum, although I entertain a high respect for him. Mr. Nutt has evidently borrowed the idea from Huber, whose work on bees was translated into English so long ago as 1808; and although he has positively asserted that he never obtained any knowledge of bees from books, many persons like myself will be incredulous, knowing he could avail himself of the discoveries of Huber twenty-four years before his own book was published. My incredulity is increased by the praise he lavishes on the discovery of Shirach, which he tells the learned lord he had proved satisfactorily to his own mind, although, from his ignorance of every thing respecting the true economy of bees, I believe him incapable of performing such an experiment. I was convinced he had read Huber when I first addressed you; and when I knew nothing of his book but through the medium of the Mechanics' Magazine, by his using the following expression, "How is the queen bee impregnated?"—which is copied from Huber. Mr. Nutt describes the queen's leaving the hive as follows: "She leaves the *royal cradle impregnated* with the royal larvæ, and withdraws from the hive, unwillingly,—no doubt." If there be such a degree of unwillingness on the part of the old lady to withdraw from the hive, why does she not wait a few days, when, if I understand Mr. Nutt's expression, the impregnation of the royal cradle would have arrived at that stage which, by accoucheurs, is called parturition, which would have obviated the necessity of the journey? The laborious experiments of Huber, to ascertain whether the old queen departed from the hive with the first swarm, were undertaken at the suggestion of the French naturalist, Bonnet, to whom all Huber's letters detailing the result of them are addressed. Bonnet, in a very long letter which he wrote Huber at the time, urged him in the strongest language never to mutilate the queen, but to mark her on the thorax conspicuously, with a varnish that would resist humidity, and produce no injurious effects. This advice Huber, however, pertinaciously rejected; for, in every experiment he gives an account of, he invariably deprived the queen of one of her antennæ. Now, Bonnet, in giving such advice to Huber, must have been well aware that by mutilation the habits of the insect would be altered; indeed it is so, if the creature is only deprived of a limb—how much more, then, when deprived of such an important organ

as the antennæ, which he allows are either the organs of feeling or smelling. He admits, also, that depriving a queen of *both* antennæ was productive of most singular effects. From the moment of its being done, there was a very great alteration in her conduct; she was sometimes quite motionless, at others she traversed the combs with great rapidity, and if she wanted food from the working bees, she directed her trunk for the purpose of receiving it with an uncertain kind of feeling, sometimes towards the bees, and sometimes against the combs; and if her trunk did reach the mouths of the bees, it was by chance. She also appeared tormented with a desire to leave her habitation, and he found it impossible to keep her in the hive: neither would the bees follow her in this mutilated state—indeed, they appeared perfectly indifferent what became of her. If this be the consequence of amputating both the antennæ, why then persist in mutilating the insect at all, particularly when in direct opposition to the advice of the person for whose satisfaction the experiments were undertaken? If such effects were produced by depriving the insect of both antennæ, is it not natural to suppose that the amputation of even one must produce some great alteration likewise in the insect's conduct, such as being tormented with a desire to leave the hive? I am convinced it does create this desire, and that it is carried into execution the first moment she can induce a swarm to accompany her. My opinion is strengthened by what Huber says, that his bees always swarmed when he had no expectation of their doing so; for it always happened after his secretary and himself had been engaged in experiments with them, and had gone away. I never shall be of Huber's opinion, until I hear of a series of experiments conducted in the manner suggested by Bonnet, and attended with similar results to those recorded by him. He admits that, when in a perfect state, the bees will never allow, for any length of time, more than one queen to remain in a hive, in consequence of the natural animosity that exists between them; although when deprived of one antennæ each, they will permit two, and the queens cease to retain their usual enmity to each other.

It is absolutely astonishing with what facility Mr. Nutt, according to his own account, has been induced to adopt the idea of the old queen leaving her hive with the first swarm, for the following is an account of the whole of his researches on the subject: he has, he says, sometimes on the evening a hive has swarmed—sometimes on the second, at other times on the third, evening afterwards—fumigated the hive, dissected and examined the combs and queen cells minutely, and whenever he has found a queen it has always invariably been a young one; but in general, he has only found a royal cell, just ready as it were to give birth to a successor to that which had left the hive. In this easy and expeditious way does Mr. Nutt solve a problem, which occupied the indefatigable Huber and his equally indefatigable secretary many years. Even in this experiment, as it is called, trifling as it is, he is incorrect. He says, the queen withdraws from the hive, leaving the royal cradle only impregnated. I once had a swarm that settled on a post, and in hiving it the queen was killed; the bees in consequence returned to the hive. The same evening the usual noise, which is made before a second swarm, was made, and I distinctly heard it from different parts of the hive at the same time—a proof, that instead of the royal cradle only being impregnated, there were two queens actually then in existence; the hive swarmed early the next morning. Reaumur, who studied the habits of bees many years, and is called, from the great knowledge he acquired of the insect, the historian of bees, did not believe the old queen left the hive; and Huber admits he never in any other instance found him inaccurate. An ancient author, named Publius Virgilius Maro, has recorded his opinion against Mr. Nutt very decidedly in the following words, as rendered by Dryden:

> "The youthful prince, with proud alarm,
> Leads out the vent'rous colony to swarm."

The same author informs us that the evil of bees swarming, which Mr. Nutt now so feelingly deplores, existed in his time, and recommends, when such a distressing event occurs, to mix with tinkling brass "the cymbal's droning sound;" and as I am resolved such a laudable practice shall not fall into desuetude through any neglect of mine, and not possessing any cymbals, I use an instrument, probably unknown to my ancient author, yclept a warming-pan, which I find from experience answers equally well. Butler, whose work, the "Feminine Monarchie," was translated into Latin in 1671, believed a young queen led the first swarm. John Geddie, Wildman, Bonnor, Mr. John Hunter, and many other authors, were of the same opinion. I do not possess the works of Aristotle or the Elder Pliny, and therefore cannot avail myself of those great authorities. It very frequently happens, when a swarm issues from a hive it returns almost immediately. This is occasioned by

the queen falling to the ground or being unable to fly. On being missed by the bees they return; and in general she can easily be found on the ground with a small cluster of bees surrounding her; and if examined, she will be found to be a young one, unable to fly. The circumstance is noticed by many authors—I know even of instances that have occurred this year. Mr. Nutt appears to be of opinion that the queen is an amalgamation of both sexes. He doubts whether there is any male bee, and says the fact is the queen is both virgin and mother; although, according to his own book, the queen carries on the business of procreation in what he calls the Pavilion! Afterwards he says there is no copulation. If I understand any thing of my own language, both words have the same meaning. When the learned lord asks him how generation was brought about, he finds himself at such a nonplus as to be incapable of an answer, but turns the discourse, and says he is confident neither drones nor working bees lay eggs. No person supposes the drone does; but Huber is of opinion that there are fertile working bees. Mr. Nutt says that even the indefatigable Huber never discovered the precise way in which the queen bee was impregnated, but imagined it took place in the air, and that he *modestly* acknowledged he never witnessed the act of copulation. Mr. Nutt should have omitted applying the term *modest* to such a man as Huber, for there may be persons who will draw a comparison between the modesty of Huber and himself, and I will not say he would benefit by the comparison. Huber not only supposed the act of coition took place in the air, but that the drone died immediately after it was effected. I believe his ideas are correct. It is well known what takes place in the air with the common house fly; the same thing takes place with the white butterfly and the common May-fly. The male of the latter dies shortly after coition, as Huber conjectures is the case with the drone; for the effect is the same as when a bee uses its sting, death being the consequence. Mr. Nutt makes strange assertions; he says the royal larvæ are *always* in existence. In another place he states, that if it were not for the great heat caused by the drones, that are never seen but from May until the end of August, the young larvæ of all the bees would undoubtedly perish. But how do the drones themselves come into existence? In the very next page he asserts, that the bees of a well populated hive will always bring to perfection the queen's eggs that have been deposited in the cells after the total destruction of the drones. Shortly afterwards a new light opens on Mr. Nutt, and he now doubts the accuracy of his opinion, so positively expressed in his conversation with the learned lord, that the queen bee was both virgin and mother. In short, he says, "I now see no objection to Huber's theory, although there is no direct proof of the copulation of the queen with the drone." All apiarians agree—indeed it is impossible to deny—that there are male and female in a hive of bees. Mr. Nutt very shrewdly observes, that although no person has ever observed the act of coition, it is, no doubt, performed in a way cnnsistent with the law of nature! A very candid admission.

It was my intention to have made some remarks on Mr. Nutt's pretensions to entomological knowledge, but find, on a careful perusal of his book, that he is absolutely ignorant of every part of the science. I now close my remarks on his book, requesting your acceptance of my grateful acknowledgments for the insertion of them in your very useful Magazine.

I am, Sir, yours, &c. J. P. T.

June 24, 1834.

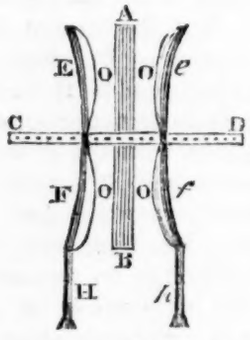
Application of the Principle of a Balance.

[From the American Journal of Science and Arts.]

The principle of a balance is a powerful one when ingeniously and judiciously applied to mechanics and the arts. Its applicability is universal. There are few if any machines now in operation that are not dependent upon this principle, or to which it cannot be beneficially applied. Look at the numerous machines employed in the various manufactories of Europe and America: how diversified, how multiplied, and how complex their operations; what a consumption of power is required to work or move them; what expense is incurred, and how great is their performance; nevertheless, how few are the parts, and simple the motions, absolutely necessary to answer, if not overrun this performance. Indeed, what cannot man do on the principle of a balance, and what can he do without it. With it, with liberty to exert his power, he might displace the world; and without it, how limited would be his influence in mechanics and the arts, and how small his accessions of power and profit derived from that source. I conclude my premises (as effects balance causes, and causes effects,) by suggesting that some of the greatest discoveries yet to be developed to the world may, in all probability, be founded on the powerful and universal principle of a balance, which pervades not only me-

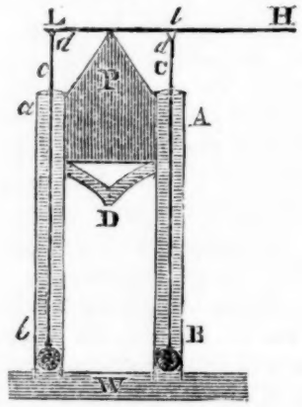
chanics and arts, but every part of the universe.

Fig. 1.



1. Application to Milking.—Fig. 1 represents a machine for milking. A B represent a light block, five inches long, three wide, and an inch and a half thick. C D represent a ruler-like piece of wood, or metal, five inches long, one third of an inch thick, and two thirds wide, perforated with holes at every sixth of an inch from end to end. This piece, C D, is to be firmly inserted, and fastened at right angles in the middle of the block A B. E F, *e f*, represent two similar, strong, light, thin boards, a little curved from their centre, each five inches long, three wide, and half or two thirds of an inch thick. H *h* represent the handles, which can be formed in connection with the boards, or attached separate. The boards are to have each one mortise, cut through its middle, of a sufficient size for the easy and regular motion of the ruler-like piece C D. Holes are to be made at right angles through the centre of each of these mortises, corresponding with those in the piece C D, so that by means of small pins or screws, these boards, E F, *e f*, can be moveably hung nearer or farther from the block A B, as required. o o o o, represent the spaces between the block A B, and boards E F, *e f*, which the teats are to occupy to be milked. The sides of the block A B, and the inner sides of the boards E F, *e f*, are to be lined with leather, or some other soft substance, stuffed with cotton, &c. so as to be elastic and press easy against the teats and not injure them. This lining should be harder, and project farther, the nearer it comes to the upper sides of these boards and blocks; so that when the pressure is given, it will commence at the upper parts of the teats and gradually increase downwards, till all the milk is forced out. Instead of this stuffed lining, springs, spiral wires, or some other elastic substance, may be used; perhaps springs are best. To work this machine, it is to be supported by the hands by means of the handles H *h*, in such a position that the teats will hang down between the block and the boards at o o o o, two teats each side of the piece C D. Both handles are to be moved inwards and then outwards, either fast or slow, so that the operation of milking can be performed or regulated at pleasure. When the handles are moved inwards, the two nearest teats to the milker will be milked; when moved outwards, the two farthest; and thus, as the motions can be so quick, there will almost flow four streams, till the operation is performed. Instead of communicating the pressure on the outside, it may be applied on the inside by altering the construction a little. This machine is applicable to other purposes allied to the operation of milking. The construction, dimensions, weight, and quality of the materials are variable, but the principle of operation is the same.*

Fig. 2.



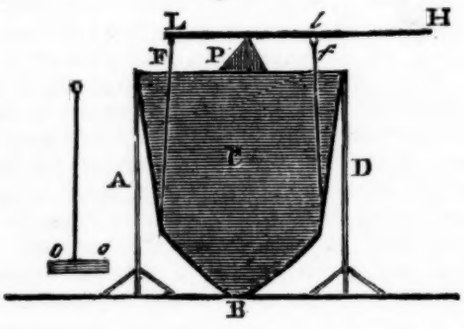
2. Application to Pumping.—Fig. 2 represents a balance suction or forcing pump, for water or air, wherein there is no loss of motion. W represents a body of air or water. A B, *a b*, represent two similar hollow cylinders, whose lower ends are inserted perpendicularly, equidistant, and parallel in the body W of air or water. P represents a pivot, which firmly connects the top of the cylinders, and across which the balancing lever L *l* is to be moveably hung and poised. H represents the handle of the lever L *l*. C *c* represent two similar piston rods, whose upper ends are moveably hung to the lever at *d d*, and to whose lower ends are attached either pistons or valves, as it is designed for a suction or forcing pump. D represents the pipes of both cylinders, united to convey off the air or water. It can be conveyed off separately. This is operated by an upward

* Having stated to the author some doubts as to this new process of milking, we have received his assurance that he has proved it practically, and that he desires its publication.—[Ed.]

and downward motion of the handle H. Any equal number of pumps, either suction or forcing, of equal dimensions, can, by being connected on this principle of a balance, be worked or moved by one handle. This application is susceptible of numerous modifications.

3. Application to Churning.—Fig. 2 will serve to illustrate its application to churning. A, B, *a b*, represent two churns; C *c*, their dashers or piston-rods; L *l*, the balancing lever; H, its handle; P, its pivot, which connects them the same as the cylinder A B, *a b*. It is worked by an upward and downward motion of the handle H. This construction may be modified into a forcing or piston churn, by having a communication at the bottom between them, to force the cream alternately from one into the other. Instead of two churns, one churn resembling those commonly wrought by a crank, with a piston through the middle, and an aperture through that, would answer the purpose. I am of the opinion, that, in churning, the cream would gather sooner, and form butter, by being powerfully forced alternately through small apertures, than by any other means, unless it be by adding some substance or composition that will immediately fetch it. Instead of the cream's being forced from one churn into the other and backwards, constantly, a small wheel full of holes, (the lids of the churns being made tight and fast,) might be attached to the lower end of each piston-rod or dasher, and made to operate up and down, and answer the same purpose, or a better than the former method.

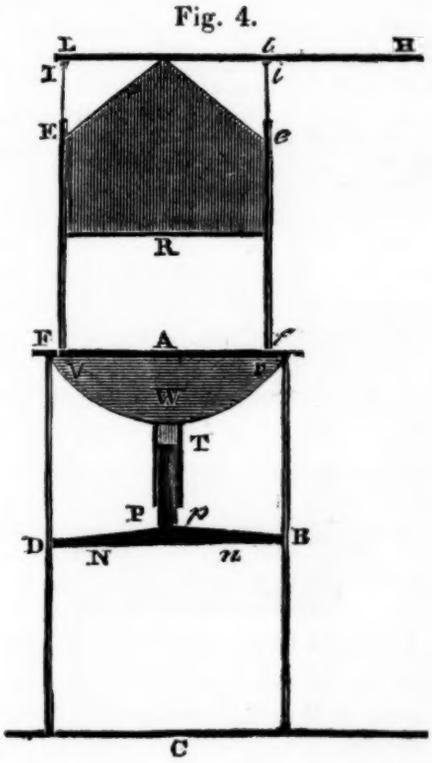
Fig. 3.



4. Application to Washing.—Fig. 3 represents a washing machine. C represents the cistern, which can be lined with rollers on the two sides A D, to hold the water and the clothes to be washed; three feet high and three wide; A B D, its frame; P, the pivot; L *l*, the balance lever; H, its handle; F *f*, the rods on which the washers, beaters, or rollers, are hung; *o o* represent a beater, &c. attached to its rod F or *f*. This machine is operated by the upward and downward motion of the handle H, and can be variously modified.

5. Application to Fulling.—Fig. 3 will serve to illustrate its application to a fulling-mill or machine. There are two constructions to this application: a vertical and horizontal. Fig. 3 enlarged will represent the vertical one. The horizontal one is nearly the same as the vertical, only that the lever and rods have a horizontal motion, and the cistern must be modified a little to answer it. In both constructions the operating power is to be applied to the handle H.

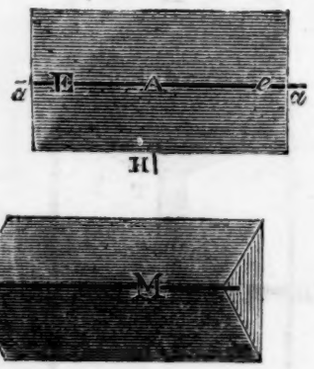
Fig. 4.



6. Application to an Aerostatic or Hydrostatic Press.—Fig. 4 represents an aerostatic or air, or a hydrostatic or water press: A B C D, its frame; W, the air or water cistern, which in shape resembles the segment of a hollow sphere or hemisphere; T, a strong hollow cylinder inserted in or attached to the bottom of the cistern; N *n*, the follower, a strong bar, fitted to move up and down in the sides D B of the frame. To this follower is attached the piston P *p*, which is exactly fitted to move up and down in the cylinder T, so as to prevent the escape of air or water. The pressure of this press is given between the follower N *n*, and the side of the frame C. E F, *e f*, represent two hollow pipes, whose lower ends are tightly inserted into the cistern W. V *v*, two valves

that exactly cover the lower ends of these pipes, and open sufficiently into the cistern. R, the pivot of the operating lever, which connects the top of the pipes; L *l*, the operating lever; H, its handle; I *i*, two rods that move up and down in the pipes, whose upper ends are moveably hung to the lever L *l*, and to whose lower ends are attached wheels or pistons with valves in their centre, opening downwards, exactly fitted to move up and down, and not allow the escape of air or water. To give the pressure either by air or water, it is admitted into the top of the pipes, passes through the valves in the wheels and the valves V *v*, until the cistern is full; the handle H is then to be worked, and the water or air will force down the piston P *p*, and consequently the follower N *n*, and press whatever is between it and C. To take off the pressure, the air or water can be let out of the cistern. Pistons might be used in the pipes. This press is susceptible of numerous modifications and applications.

Fig. 5.



7. Application to Printing.—Fig. 5 represents a printing machine. A represents an oblong table or frame, set full of types, and balanced on its axle E *e*, which supports it at *a a*, moveably in two upright standards. H represents the operating handle; M, a heavy or solid, oblong, triangular block, as wide and long as the table, over which it is to be firmly hung, so that one of its angles will run parallel and laterally with its axle E *e*. The two sides of the block M, immediately over the types or against which they will press, when the handle H is operated, must be lined with some elastic substance, in order to give a good impression. The types are to be inked by inking rollers, and the paper applied by hand or machinery. Instead of the table being moveably hung, and the block fixed, it may be reversed: the table fixed and block moveably hung. Instead of the block being triangular, and table flat, the block may be flat, and the table triangular. Every motion of the handle H, either upwards or downwards, will give an impression. H. Strait.

East Nassau, Rensselaer co., N. Y., April 28, 1834.

Improvement in Railways.—It has been resolved to make trial, on the Birmingham railway, of slabs of slate fixed in a bed of concrete, as a substitute for the usual stone sleepers. We have since been informed that, in an experiment previously made on the premises of Messrs. Cottam and Hallem, in the presence of the engineer and several of the directors of the Company, it was found, by the hydraulic press, that a cubic inch of slate will sustain a pressure of three tons and a half, and that consequently slate of an inch and a half thick is more than equal to any pressure which it can be required to support on a railway. The saving in expense, if slate is ultimately adopted, will be at least one half.—[Engl. pap.]

American Journal of Science and Arts, for July, August, and September.—The number before us is in no wise calculated to diminish the well-earned reputation for ability which this journal has so long possessed. Amid its varied contents, we have read with the greatest pleasure the Report on the projected Geological and Topographical Survey of the State of Maryland. This report is intended only as an introductory account of the geology and hydrology of the State, with a view of inducing the Legislature, in its coming session, to authorize their more thorough investigation. There is but little doubt, we learn, but what a liberal appropriation will be made, to bring to a completion what the authors of this report have so successfully commenced. But why is it, we would here ask, that while such States as Massachusetts, Maryland, Virginia, and Tennessee, have either completed or are now carrying on surveys of a like character, our own State has done nothing towards a developement of her physical geography? As regards its "mineral constitution," we may safely say, that with the exception of the iron at Ramapo, and the salt at Salina, there is scarcely any thing known. That our State is eminently rich in wealth of this nature, from which might be drawn a fruitful source of revenue, there is no reason to doubt. Our public as well as individual interest require that that scientific information on the subject of our agricultural and manufacturing resources, which can only be obtained by means of surveys like the above, should be furnished without delay.—[Railr. Journal.]

The *Mechanics' Magazine and Register of Inventions and Improvements* is published by the Proprietors, D. K. Minor and J. E. Challis, at No. 35 Wall street, New-York: in *weekly* sheets of 16 pages, at 6¼ cents—in monthly parts of 64 pages, at 31¼ cents—in volumes of 384 pages, in cloth boards, at $1.75—or at $3 per annum, *in advance*.—John Knight, (formerly proprietor of the London Mechanics' Magazine,) Editor.